Title: **Innovative Instrumentation and Analysis of the Temperature Measurement for High Temperature Gasification.**

PI: Seong W. Lee, Ph.D., Associate Professor
Students: Yun Liu, Shijun Zhu, James Ngeru, Moses Mukira, Edikan Bassey and Donald Lawson
Institution: Morgan State University
Address: School of Engineering, 5200 Perring Parkway, Baltimore, MD 21239
Telephone: (443) 885-3106/2732
Fax: (443) 885-8218
Email: slee@eng.morgan.edu
Grant Number: DE-PS26-02NT41681
Performance Period: 10/01/2002 – 3/31/2004

1. ABSTRACT

Objectives:
The temperature measurement in the gasifier, under harsh conditions, is a great challenge in terms of robust operation and corrosion/erosion prevention. The objective of this research is to develop innovative instrumentation and analysis for high temperature measurement in gasification using the specially designed thermocouples along with two cleaning methods. The ultrasonic dirt peeling and high-pressure oxygen injection cleaning are two methods to clean the thermocouple tip for accurate and robust measurements. The anti-erosion/corrosion sprayed coating on the thermocouple could make the thermocouple specialized and unique.

Accomplishments to Date:
The cold test model and the hot test model of the proposed gasification simulator have been designed and fabricated for the systematic tests along with the thermocouple assemblies at the Center for Advanced Energy Systems and Environmental Control Technologies of Morgan State University.

The cold test model is made of a transparent acrylic tube with 10-inch ID and 20-inch length. This model allows us to observe the phenomena of the gasification process, which may cause dirty and harsh environments around the thermocouples. The air injection system is attached to the cold model testing system, which includes an air compressor, an air control valve and the auxiliary tubes. The charcoal dust mixtures are used in the cold model to simulate the gasifier environment. The experimental design technique is being carefully implemented along with four (4) different testing parameters; charcoal dust weights, irritating air flow rates, irritating air frequency and the ultrasound applications. The Analysis of Variance (ANOVA) was applied to analyze the cold model test data. The analysis results show that all four factors are significant to the temperature measurements in the gasifier simulator (cold model). The regression analysis results for the case with the normalized room temperature shows that linear model fits the temperature data with 82% accuracy (18% error). The regression analysis for the case without the normalized room temperature shows 72.5% accuracy (27.5% error). The nonlinear regression analysis results indicate a better fit than that of the linear regression. The nonlinear

regression model's accuracy is 88.7% (11.3% error) for normalized room temperature case, which is better than the linear regression analysis.

The preliminary test is conducted using the gasifier simulator (hot model). In the systematic test, two (2) factors - airflow rate and water flow rate, are set to two (2) levels, high and low respectively. A water-feeding device is carefully designed and installed to the gasifier simulator. Analysis of Variances (ANOVA) is applied to the results from systematic tests. The ANOVA analysis results show that the airflow rate has the significant impact to the temperature measurement in the gasifier simulator. The ANOVA analysis results also show that the water flow rate does not have significant impact to the temperature measurements in the gasifier simulator. The ANOVA analysis results indicate that the proposed thermocouple assembly could take accurate temperature readings in the moisture environment of the gasifier.

The vibration application to the thermocouple is implemented to explore the thermocouple tip cleaning. Both ultrasonic and sub-sonic vibrations are under consideration. The preliminary test results indicate that the thermocouple vibration using unbalanced high-speed motor does not have significant impacts to the temperature measurements in the gasifier simulator. Another series of vibration tests is being conducted to determine the natural frequency of the possible melted ash layer on the thermocouple tip.

Future Work:
Continue the harmony vibration tests up to ultrasonic frequency ranges.
Continue the systematic tests in consideration of all five experimental factors.
Evaluate the impacts of these five factors.
Develop the control system for the temperature measurement device.

2. LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENTS RECEIVING SUPPORT FROM THE GRANT

Symposium Presentation

"Innovative High Temperature Measurement and Analysis in a Gasifier Simulator", Zhu, S., Y. Liu, J. Ngeru, and S.W. Lee, to be presented and published in the Proceedings of 11th Annual Undergraduate and Graduate Science Research Symposium, April 2004, Baltimore, MD.

Students Supported Under this Grant:
Yun Liu, Shijun Zhu, James Ngeru, Moses Mukira, Edican Bassey and Donald Lawson. They are all undergraduate and graduate students in Industrial, Manufacturing and Information Engineering Department, Morgan State University.